

A geochemical budget of 8 Myrs of oxidative ocean basement alteration

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Interactions between circulating seawater and basalt in the flanks of mid-ocean ridges are key in controlling ocean chemistry and subcrustal life. But geochemical investigations of ocean-basement exchange are difficult when the basement has been sealed and rock compositions were partially reset by close-system processes of little relevance to ocean fluxes.

We report geochemical compositions (majors, traces, H₂O, CO₂, S, Fe(iii)/Fe_{total}) and Sr isotope ratios of sixty whole rock samples collected from drill core (to 335 m seafloor) retrieved during IODP Expedition 336 to the North Pond area at 22°45'N and 46°06'W on the western flank of the Mid-Atlantic Ridge. The basement age is about 8 Ma at this site, where off-axis circulation of seawater continues vigorously today and removes about 100 mW/m² of heat from a 8x15 km sedimented area. Because the basement has been ventilated by oxygenated seawater throughout its lifetime, the North Pond area is a much needed reference cite for assessing geochemical exchange fluxes in a prolonged period of a key hydrological state, in which crust-basement exchange is unobstructed by sediment sealing.

The basement is heavily oxidized (Fe(iii)/Fe_{total} ratios increase from 0.1 to 0.8) and hydrated (H₂O concentrations go up to 3.7 wt.%). Water contents and iron oxidation state are correlated very well for samples from the uppermost 200 m of basement; whereas deeper samples appear less oxidized. ⁸⁷Sr/⁸⁶Sr ratios increase from 0.7024 to 0.7040 as water contents go up. These tight correlations attest to steady oxidative alteration affecting basement composition at the site. The associated geochemical changes include losses of silica (<10%), Mg (<50%), and S (<80%) and gains in alkalis (K>Rb>Cs>Li>Na), Ba, P, and U (up to 20 times enriched). CO₂ uptake is overall minor, although carbonate veins and void fill in the lower basement are observed in rare intervals (up to 2.3 wt.%). Quantitative flux estimates, using weighted averages that make use of downhole geophysical logging and systematic documentation of alteration features in drill core samples are underway and will be presented at the meeting.